Operational Coordination

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Operational Coordination

Frequency is logarithmic (DC to light and beyond), but usable frequencies are finite and are allocated internationally to specific services.

If too many people try to use the

- Same frequency/frequencies at the
- Same place at the
- Same time

Interference will result.

This situation may be called a time-place-frequency conflict.

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Time-place-frequency conflicts have happened before when

- 1 ground station (name withheld to protect the innocent), had
- 2 antennas tracking
- 2 satellites, and
- bad timing

(both spacecraft simultaneously lost lock for ~ 1 minute).

Post pass analysis revealed that the two satellites had passed within a few degrees of each other at the time of the simultaneous dropouts.

Now they schedule more carefully, but

- They scheduled both spacecraft (good news), and
- They are in a very popular location (very bad news).

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For good reasons, most Earth Science Spacecraft, both public and private, are:

- In sun-synchronous orbits,
- Many at a preferred altitude of ~705 km (~98 minute orbital period),
- With preferred equatorial crossing times (e.g., 6:00 AM, 10:00 AM, and 1:30 PM local satellite time).

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These good reasons conspire to increase the likelihood of conflicts.

- Sun-synchronous spacecraft with the same equatorial crossing time but different altitudes will “walk across one another.”

- Sun-synchronous satellites at the same altitude but different equatorial crossing times will cross their orbits at high latitudes – where the prime ground stations are located.

Earth Science Enterprise
National Aeronautics and Space Administration

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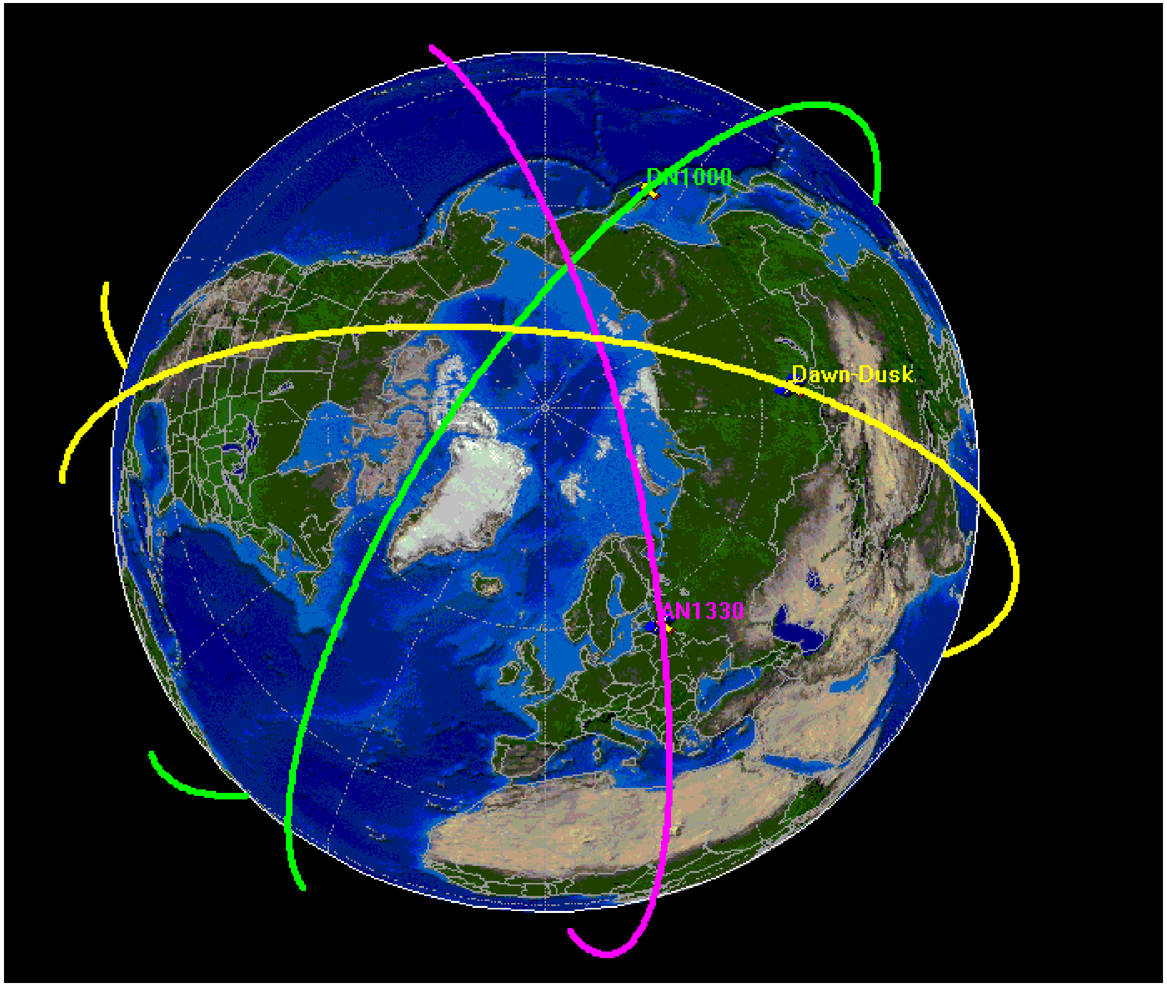

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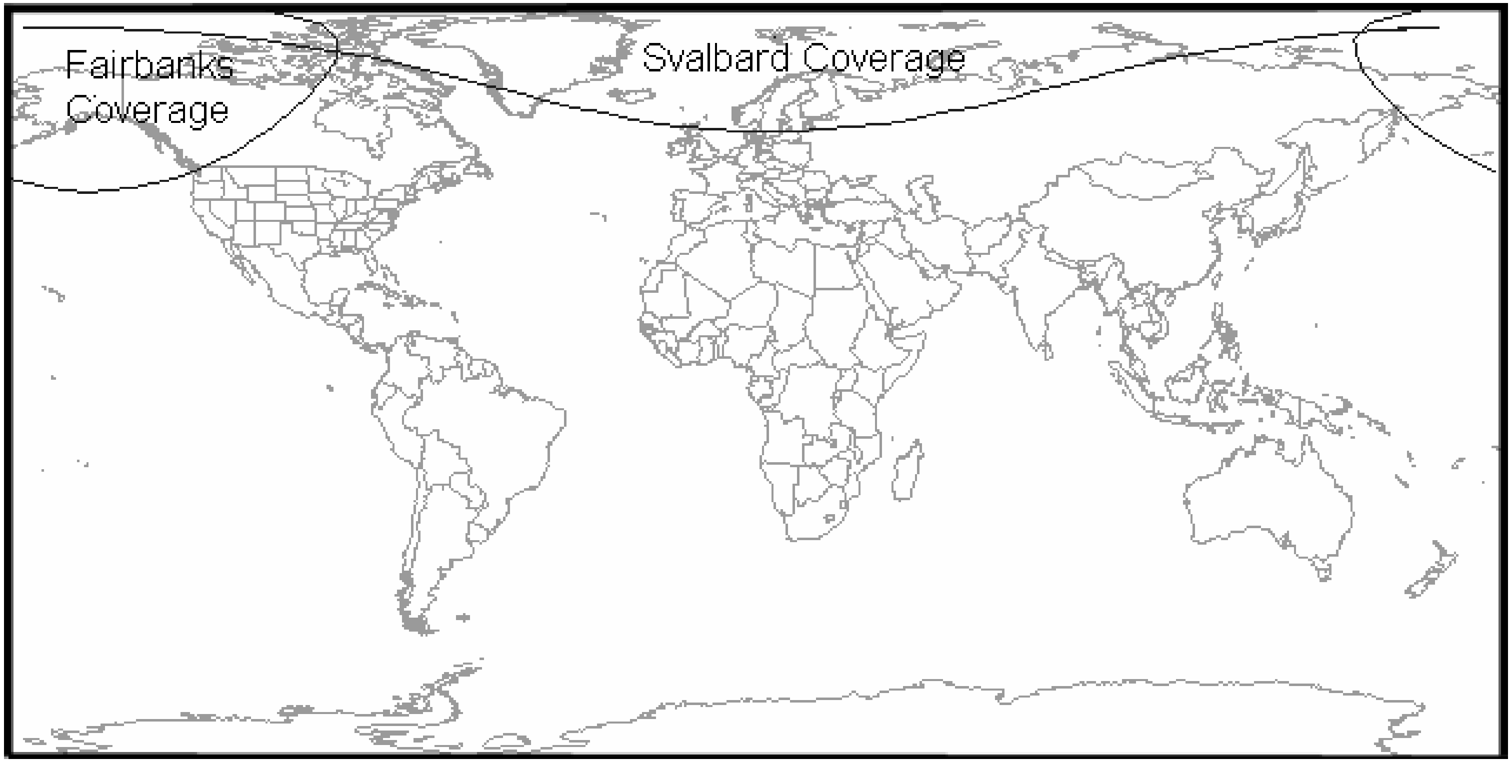
Add in the highly desirable polar ground stations, and conflicts are likely.



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A large number of high bandwidth missions are considering using 8025-8400 MHz.

Some scientific:

- NASA's Earth science missions

Some operational:

- NPOESS, the next generation weather satellites

Some commercial Earth remote sensing:

- Ikonos
- IRS
- Quickbird
- Radarsat-2
- Resource 21 (one or more satellites)
- SPOT

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Frequency dispersion won’t work if too many users each require too much bandwidth (despite the technology).

Geographic dispersion won’t work if the ground stations are too close together.

Temporal dispersion won’t work – the time over ground stations is driven by orbital mechanics (can’t stop a satellite).

Operational coordination may become necessary to resolve the time-place-frequency dilemma. What is “operational coordination”?

Operational coordination is the procedure invoked when spacecraft operations have to be modified by one or more parties to avoid a radio frequency conflict which would result in the loss of communications to one or all affected parties.

(an unofficial working definition)

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Examples do exist:

While supporting a FAST mission pass, a tracking station:

- **Found a satellite at zenith with 2x the signal strength,**
- **Autotracked the “other” satellite without losing lock or gaining CRC or seq. errors,**
- **Tracked the “other” satellite to LOS at the horizon, then**
- **Came out of autotrack, found the correct satellite, and re-acquired within seconds.**

Nothing appeared out of the ordinary until the first LOS!

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Examples do exist:

TERRA spacecraft direct broadcast operations are coordinated with the Deep Space Network observing schedule:

- When TERRA passes too close to the beam of an antenna in use, TERRA turns off its direct broadcast service (typically seconds to a few minutes).
- The alternative of turning off from horizon-to-horizon would deny TERRA direct broadcast data to the Western United States, most of Europe, and most of Australia.
- The time-place-frequency dilemma is resolved by temporarily, for the shortest reasonable time, turning off the interfering signal.

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Examples do exist:

In a somewhat similar situation, the ITU assigns geosynchronous communications satellites both

- **a spectrum allocation and**
- **a location (longitude) assignment.**

Since the broadcast/communications satellites are usually on all the time, time-place-frequency conflicts are resolved by assigning <u>both</u> place and frequency.

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One approach is to set up a "Coordination Office" which:

- **Keeps up-to-date orbit parameters and ancillary information for all spacecraft in the band and using ground stations within the affected area,**
- **Runs orbit predictions several days in advance,**
- **Keeps up-to-date information posted on the WWW, and**
- **Notifies both/all parties when a time-place-frequency conflict is likely (potential conflicts are assumed to be a matter of geometry, frequency, and time).**

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At this point, either

- the affected parties have an agreed-to protocol (e.g., my turn, your turn, etc.) or
- The affected parties must negotiate on a pass-by-pass basis.

Per ITU regulations, when band users have a primary allocation in the band, they must coordinate with other primary users when interference exists.

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Issues:

Is such a Coordination Office needed?

If the answer is yes (or probably), then:

- **When is it needed?**
- **Where is it needed? (more than one?)**
  - **What is the geographical area to be encompassed?**
  - **How is it determined?**
- **Who sets it up or is in charge? Industry and/or Government?**
- **How is it funded?**

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Issues (continued):

- How does the Office ensure that it gets <u>all</u> the orbital data it needs, and that it is timely?
- How are orbit adjustments (e.g., to correct for atmospheric drag) handled?
- Until new orbits are reached and confirmed, how does the office function – predicted data updated when and by whom?
- What are its authority, responsibilities, and liabilities?
- What are user/customer responsibilities and liabilities?
- How are “non-subscribers” handled?

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What next step needs to be taken?